BEFORE THE
POSTAL REGULATORY COMMISSION

PERIODIC REPORTING	)	Docket No. RM2016-2
(UPS PROPOSALS ONE, TWO AND THREE)	)	

REPLY DECLARATION OF JOHN C. PANZAR
ON BEHALF OF
AMAZON FULFILLMENT SERVICES, INC.

March 25, 2016

1. Introduction and Summary

My name is John C. Panzar. I am Professor of Economics in the Business School of the University of Auckland and Louis W. Menk Professor of Economics, Emeritus at Northwestern University. My professional work has included analysis of economic pricing and costing principles for the United States Postal Service and other multiproduct firms. I have sponsored testimony to the Postal Regulatory Commission and its predecessor, the Postal Rate Commission, for several parties (and the Commission itself). In 2014, the Commission contracted with me to prepare a report on the proper role of costs for postal regulation.[1] On January 25, 2016, I submitted a declaration for Amazon Fulfillment Services, Inc., in this docket, *Periodic Reporting (UPS Proposals One, Two and Three)*. That declaration evaluated Proposal One of United Parcel Service, Inc. ("Proposal One").

In the present declaration, I reply to certain economic claims made in the initial comments of three other parties: National Postal Policy Council ("NPPC"), Valpak Direct Marketing Systems, Inc. and Valpak Dealers' Association, Inc. ("Valpak"), and the Public Representative ("PR").[2] As explained below, all three commenters confuse a product's incremental costs, *i.e.*, the costs actually *caused* by that product, and the costs that would be *allocated* to that product under Proposal One.[3] The two are not the same. Proposal One would

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[1] Panzar, John (2014): "The Role of Costs for Postal Regulation," Postal Regulatory Commission.

[2] Comments of The National Postal Policy Council, January 27, 2016; Valpak Direct Marketing Systems, Inc. and Valpak Dealers' Association, Inc. Initial Comments on United Parcel Service, Inc.'s Proposed Changes to Postal Service Costing Methodologies, January 27, 2016; Public Representative Comments, January 27, 2016 (Revised February 18, 2016).

[3] Proposal One — A Proposal to Attribute All Variable Costs Caused By Competitive Products To Competitive Products Using Existing Distribution Methods, October 8, 2015.

attribute *all* inframarginal costs to individual products—including the large share of inframarginal costs that are caused jointly by multiple products. These costs are not caused by any individual product, and including them in the incremental or attributable costs of individual products is incorrect and would lead to unsound pricing decisions.

In section 2, I respond to NPPC and Valpak. I present a simple diagrammatic analysis to show that many of the costs allocated by Proposal One to individual products are not in fact caused by any individual product and therefore are not part of the incremental costs of any individual product.

In section 3, I respond to the contention of the Public Representative that because marginal or attributable costs are distributed to individual products, the allocation of inframarginal costs also has a causal basis. I also correct a variety of other errors in the Public Representative's analysis.

2. Graphical Review of Incremental Costs, Inframarginal Costs and Volume Variable Costs

Both NPPC and Valpak assert that inframarginal costs are equivalent to, or a subset of, incremental costs. This is incorrect.

NPPC correctly observes that incremental costs are the proper basis for cross-subsidy tests:

> NPPC expresses no opinion on whether the Commission should redefine attributable costs to be incremental costs. However, incremental costs are the correct test for cross-subsidy.

NPPC Comments, p. 6. NPPC errs, however, in suggesting that *all* inframarginal costs are part of incremental costs. On page 3 of its comments, NPPC asserts:

> As to Proposal One, NPPC believes that inframarginal costs are part of a product's incremental costs and should be included when testing for cross-subsidy.

And on pages 6-7 of its comments, NPPC contends:

> As to the second point, despite agreement that inframarginal costs are incremental costs, there is substantial disagreement regarding how to distribute such costs among postal products.

Valpak's comments reveal a similar confusion. They repeatedly suggest that the properly calculated incremental costs of a product must include that product's proportional share of inframarginal costs. On page 2 of its comments, Valpak states:

> UPS, adopting McBride's methodology, computes incremental cost for each competitive product to include that product's share of so-called 'inframarginal' costs.

Similarly, on page 5 of its comments, Valpak adds:

> Second, a discussion of the effects of having cost attribution for market dominant products reflect all costs caused by each product, including inframarginal costs as proposed by UPS (*i.e.*, incremental costs rather than just marginal costs).

Both NPPC and Valpak are mistaken. Proposal One is not a valid alternative approach to calculating incremental costs. In fact, *only* a portion of the inframarginal costs of any cost component should be included in any individual product's incremental costs.

In the remainder of this section, I will illustrate these facts through a simple diagrammatic analysis of how the various attribution methodologies determine the amount

of component variable costs attributable to a group of "competitive products." The diagram will allow direct comparisons of the amount of component variable costs attributed to competitive products under three scenarios:

   (i)   The Commission-approved Postal Service approach, which is based upon volume variable cost;

   (ii)   The incremental cost approach; and

   (iii)   The "Shapley Value" approach of Proposal One.

The analysis is carried out for a single cost component and only two mail products. However, the conclusion holds for any number of cost components and products as long as component variable costs exhibit increasing returns to scale.

Assume that the Postal Service offers a market-dominant product (with volume denoted by Q_m) and a competitive product (with volume denoted by Q_c). Both products are provided using a single cost component with increasing returns to scale. Assume further that there are no product specific fixed costs or component fixed costs, so that all component costs are variable costs and given by the function $C(D)$, where D is the total level of driver activity required to serve the total volumes of both products. For ease of exposition, assume that the units are chosen so that, for both products, each unit of product volume requires one unit of driver activity. Thus, $D = Q_m + Q_c \equiv Q_T$ and the total costs of the component (and the Postal Service) are given by $C(D) = C(Q_T) = C(Q_m+Q_c)$. Finally, as has been done throughout this proceeding, assume that both component average costs and marginal costs are a decreasing function of the level of driver activity, as shown in Figure 1.
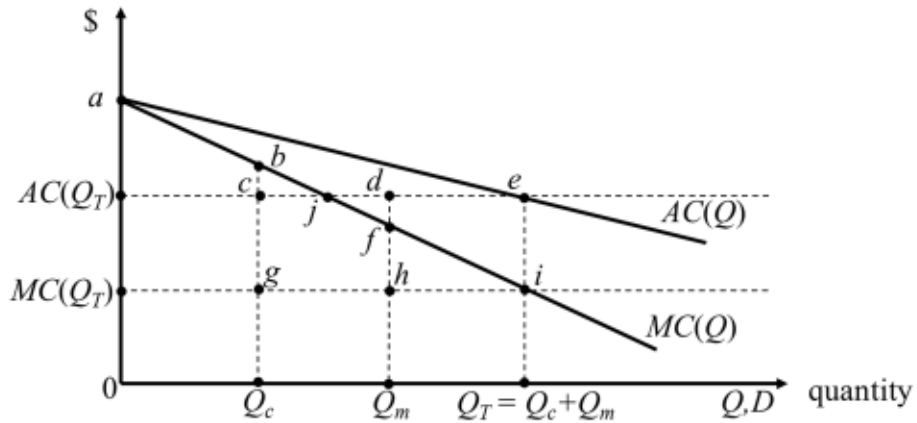
Figure 1

Figure 1 shows that the average cost curve *AC(Q)* lies everywhere above the marginal

cost curve *MC(Q)*, as must be the case when marginal costs are everywhere falling. Figure 1

also illustrates the various attribution methodologies discussed in this proceeding. However,

to do so requires a bit of explanation. Levels of product volume (and associated driver

activity) are plotted along the horizontal axis. For ease of exposition, I have taken Q_m to be

greater than Q_c. This generally reflects the current situation, but the conclusion I derive would

still be true if the relative sizes were reversed. As indicated, Q_T, the total amount of

component driver activity, equals the sum of Q_c *and* Q_m. Importantly, this means that the

horizontal distance between the diagram points Q_m and Q_T is equal to Q_c. Similarly, the

horizontal distance between the points Q_c and Q_T is equal to Q_m. These basic relationships are

central to the graphical arguments that follow.

The decreasing cost curve *MC(Q)* plots component marginal costs. This curve (or ones

similar) has appeared in several filings in this proceeding. To illustrate simply the attribution

implications of Proposal One, it is useful also to include the declining cost curve *AC(Q)*, which

plots component average costs: *i.e.*, component costs per unit of driver activity.[4] To make the diagram as clear as possible, I have assumed that the underlying component variable cost function is quadratic, so that MC and AC are straight lines.[5] Recall from intermediate microeconomics (or basic calculus) that (i) there is a precise relationship between average and marginal curves in economics; and (ii) when these curves are linear, they have the same intercept on the vertical axis and the marginal curve has twice the slope of the average curve.

As explained in the Neels' Report and elsewhere, the $MC(Q)$ curve can be used to illustrate the Postal Service's volume variable cost attribution methodology. This attribution process would involve two steps. First, *component* volume variable costs would be determined by multiplying the marginal cost of the "last" unit of driver activity, $MC(Q_T)$, by the total amount of driver activity. This total, $VVC = Q_T \cdot MC(Q_T)$, would then be *distributed* to the competitive product using the distribution key s_c. Because of the choice of units in my example, the distribution key would simply be the competitive product's share of total volume: i.e., $s_c = Q_c/Q_T$. Thus, the total amount of component volume variable costs attributed to the competitive product under the Postal Service's approach would be given by

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[4] I do not believe that this component AC curve has been used in this proceeding. However, I made extensive use of it on the analysis of Fully Distributed Costing ("FDC") that I prepared for the Office of the Inspector General of the Postal Service. OIG (2012). Office of the Inspector General, United States Postal Service, (2012); "Costs for Better Management Decisions: CRA Versus Fully Distributed Costs," RARC-WP-12-016.

[5] The conclusions derived below do not depend upon this assumption. They result only from the assumption of increasing returns to scale of the component variable cost function. If component variable costs had the constant elasticity form usually used by the Postal Service, both marginal cost and average curves would be "bowed in," *i.e.*, convex to the origin. And, as in Figure 1, the marginal cost curve would lie everywhere below the average cost curve.

$VVC_c = s_cVVC = Q_c \cdot MC(Q_T)$. In the diagram, this is indicated by area ihQ_mQ_T = area $0MC(Q_T)gQ_c$.[6]

The incremental cost of the competitive service is simply the difference between the total costs of providing *all* services *less* the costs of providing *only* the monopoly service. That is, $IC_c = C(Q_T) - C(Q_m) = C(Q_T) - C(Q_T-Q_c)$. On the diagram, this difference is just the area under the marginal cost curve between Q_m and Q_T: *i.e.*, the area Q_mfiQ_T. It is clear from the diagram that this definition attributes a greater amount of component costs to the competitive service than does the volume variability method.

It is important to note the fundamentally different role played by the distribution process in determining a product's incremental cost. Unlike the volume variability approach described above (or the Proposal One method discussed below), the determination of an individual product's incremental cost does *not* involve the *distribution* of any component variable costs to individual products. Rather, the component's distribution key is used to estimate the amount of driver activity that would be required with and without the volumes of the product in question. Given this estimated amount of *avoided* driver activity, the incremental cost of the product is calculated directly from the component variable cost function.

Finally, consider the method proposed in Proposal One. As explained by Dr. Neels, this method involves attributing *all* component variable costs, including inframarginal costs, to individual products using the same distribution keys that the Postal Service uses in its

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[6] Using the same steps, the Postal Service methodology would attribute an amount to the monopoly product equal to the area $hMC(Q_T)0Q_m = Q_m \cdot MC(Q_T)$.

volume variable approach. In my example, the amount of component costs attributed to the competitive service would equal:

$$A_c = s_c C(Q_T) = \frac{Q_c}{Q_T} C(Q_T) = Q_c AC(Q_T)$$

That is, the Proposal One approach attributes to all units of driver activity the level of average cost realized by the cost component as a whole. In Figure 1, the amount allocated to the competitive product would equal A_c = area $Q_m deQ_T$ = area $0AC(Q_T)cQ_c$. From the diagram, it is also clear that this amount is greater than the incremental cost of the competitive service (*i.e.*, by an amount equal to trapezoidal area *deif*). This is because only *some* inframarginal costs are included in incremental costs. Put another way, the costs attributed by Proposal One would exceed incremental cost because the method would attribute to individual competitive products inframarginal costs that are *not caused* by those products. This is why Proposal One is contrary to the statutory requirement that attribution be based on "reliably identified causal relationships."[7]

Proposal One and the Neels' Report do not explicitly address the implications of the Shapley Value approach for the market dominant products of the Postal Service. However, this issue is raised in the NPPC Comments and is also easily illustrated using Figure 1. Under Proposal One, the monopoly products would be allocated a pro rata share of component variable costs: *i.e.*,

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[7]"DEFINITION.—For purposes of this subchapter, the term 'costs attributable', as used with respect to a product, means the direct and indirect postal costs attributable to such product through reliably identified causal relationships." 39 U.S.C. **§** 3631(b).

$$A_m = s_m C(Q_T) = (1 - s_c)C(Q_T) = \frac{Q_m}{Q_T} C(Q_T) = Q_m AC(Q_T)$$

On Figure 1, this is given by the area $Q_c ce Q_T$ = area $0AC(Q_T)dQ_m = AC(Q_T) \cdot Q_m$. The diagram makes clear that this attribution is larger than the incremental cost of the monopoly service by an amount equal to area *deif*.[8] That is, Proposal One would also attribute costs to individual market-dominant products that are *not caused* by those products.

I conclude this section with a couple of somewhat technical points. First, as I have repeatedly emphasized, the finding that Proposal One would attribute costs to individual products that are *not caused* by those products does not depend on the linearity of the AC and MC curves. It is a direct consequence of increasing returns in component variable costs. More formally, let Q_i denote the volume of any product i (as well as the associated level of driver activity) and let Q denote the total level of component driver activity. The amount of driver activity associated with product i is then given by $s_i = Q_i / Q$. Then, the amount of component costs attributed to product i under Proposal One is given by $A_i = s_i C(Q)$, while the Incremental Cost of product i is given by $IC_i = C(Q) - C(Q - Q_i) = C(Q) - C[Q(1 - s_i)]$. Therefore, the difference, Δ, between Proposal One attribution for product i and its Incremental Cost is given by

$$\Delta = A_i - IC_i = s_i C(Q) - \{C(Q) - C[Q(1 - s_i)]\} = C[Q(1 - s_i)] - (1 - s_i)C(Q) > 0.$$

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[8] The relationship follows from the basic property, taught in high school geometry, that the similar triangles *cbj* and *dfj* must have equal areas.

The difference is positive because, when there are increasing returns to scale, a proportional *reduction* in quantity (*i.e.*, from Q to $(1 - s_i)Q$) leads to a *less* than proportional reduction in costs.

Second, the results of the analysis of Figure 1 are primarily *qualitative* in nature. That is, one should not attempt to use the diagram to measure the *magnitude* by which competitive service incremental cost exceeds its attributed volume variable cost or falls short of the costs that would be attributed under Proposal One. Making such *quantitative* determinations requires using actual component cost curves and relative volume levels.

3. Critique of the Public Representative's Comments

This section responds to the PR Comments. Those comments stated the Public Representative's belief that Proposal One "could be accepted as a method of measuring and distributing variable costs as attributable costs." PR Comments at 53. The arguments made in the PR Comments in support of this recommendation reflect a lack of understanding of the basic principles of cost causation and Postal Service costing methodology. For the reasons explained in the following pages, the Commission should disregard the recommendations of the Public Representative regarding Proposal One. In section 3.1, I discuss the most important errors relating to the attribution of costs to individual cost components. In section 3.2, I explain why the distribution of marginal or attributable component costs to individual classes and products does not justify the allocation of inframarginal costs (other than incremental costs) to individual classes and products.

3.1 Section III. A. of the PR Comments Reveals a Lack of Understanding of Postal Service Costing Methodology at the Cost Component Level.

The PR Comments reveal a fundamental misunderstanding of the Postal Service methodology for attributing costs to individual cost components. For example, the Public Representative states:

> Moreover, just as each component-level elasticity is assumed to be constant at all levels of production, each component's marginal cost is also assumed to be constant at all levels of production.

PR Comments, page 22. This statement is mistaken in two basic respects. First, it is not an accurate characterization of Postal Service methodology. As widely noted in this proceeding, the Postal Service does not assume that all component marginal costs are constant. Second, the proposition stated in the block quotation is mathematical nonsense: a constant component level elasticity can be consistent with constant component marginal costs *only* when that elasticity is assumed to be equal to one. Also, as clearly pointed out in my 2014 report and my previous declaration, it is the very fact that the volume variability of many components is less than one (*i.e.*, that marginal costs are *not constant* for many components) that gives rise to the presence of inframarginal costs in the first place. If component marginal costs are constant, then inframarginal costs are zero. Equally mistaken is the claim that "'[i]nfra-marginal' costs are defined as the difference between a *product's* variable cost and its marginal cost." PR Comments, p. 23 (Emphasis added). Inframarginal costs are defined at the *component* level, as explained in Section 2, not the *product* level. And, the correct definition at the component level is: (component) inframarginal costs are defined as the difference between (component) variable costs and (component) volume variable costs. This fundamental misconception is illustrated by Figure 1 in the PR Comments, reproduced below as Figure 2.

The Public Representative's diagram bears a superficial resemblance to diagrams that appear in Proposal One, the Neels' Report, my (2014) report to the Commission, and Figure 1 in this declaration.
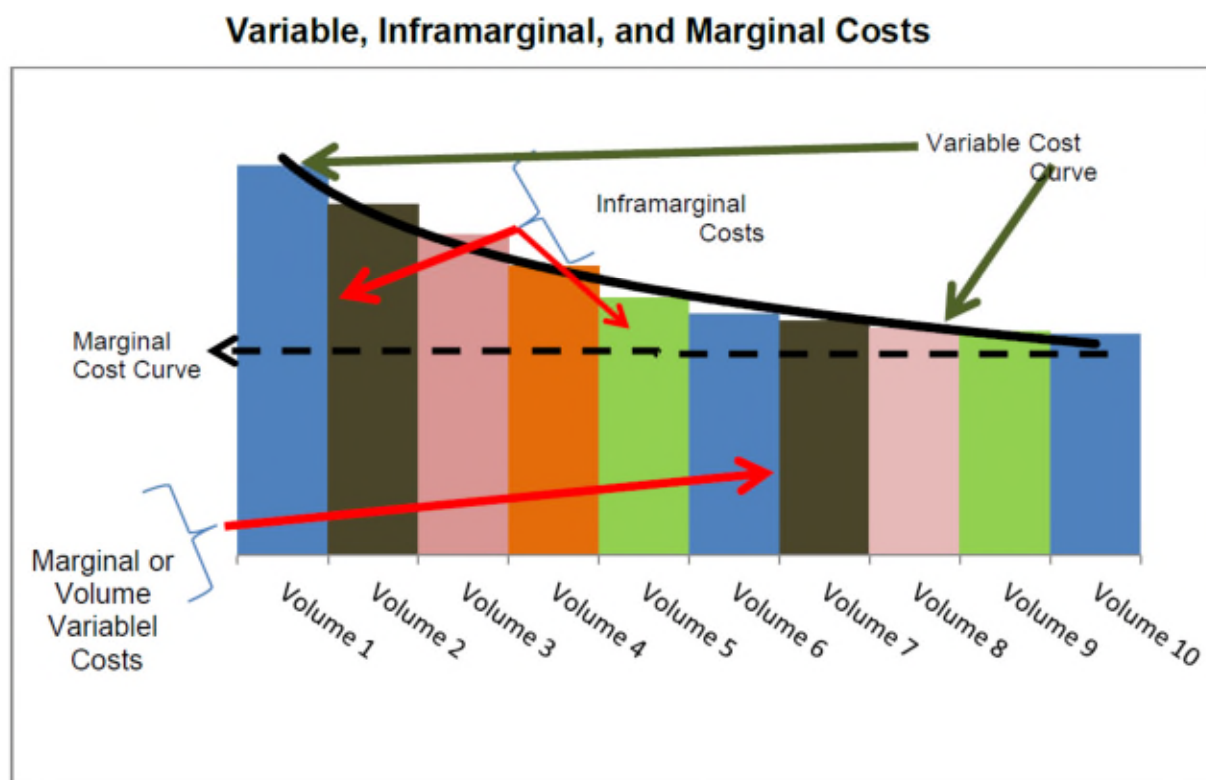

Figure 2

The apparent similarity to those (correct) diagrams is misleading, however. First, the falling curve at the top of the diagram, which should be identified as a (component) *Marginal* Variable Cost curve, *e.g.*, *MC(Q)* in my Figure 1 above (line *abft*), is mislabeled by the Public Representative as a Variable Cost curve.

Second, in a correct diagram, the dashed horizontal line would represent the level of Marginal Cost *at a particular level of component cost driver activity: e.g.*, the horizontal dotted line

MC(Q_T)ghi in Figure 1. In Figure 2, this horizontal line is mislabeled as the Marginal Cost *Curve* associated with an *assumed* constant level of component marginal cost.

Third, the Public Representative identifies inframarginal costs as the area between Figure 2's (mistakenly labeled) horizontal Marginal Cost *Curve* and its (mistakenly labeled) falling Variable Cost Curve. As explained above, this does not make sense as an economic argument, but does happen to correspond to a similarly shaped area that is *correctly* identified as Inframarginal Cost on a *correctly* labeled and analyzed diagram, *e.g.,* area *MC(Q_T)ai* in Figure 1.

3. 2 Sections III.B – III.E of the PR Comments Reveal a Profound Misunderstanding of the Postal Service's Cost Distribution Methodology and its Connection to Cost Causality and Proper Cost Attribution.

Still further errors appear in the Public Representative's analysis of Proposal One at the product level. Proposal One recommends that all component inframarginal costs be *attributed* to individual products. My previous declaration and Section 2 above explain in detail why such an attribution is unsound economics and inconsistent with the statutory condition that cost attributions must be based upon recognized principles of cost causality. I will not repeat those arguments here. Rather, I respond to the assertion of the Public Representative that the Postal Service method for distributing *attributable* costs to individual components and products supports the Proposal One allocation of *inframarginal* costs to individual components and products. The supposed similarity of the two approaches is illusory.

The Public Representative's basic misunderstanding of Postal Service cost distribution is illustrated by the following statement:

> The current methodology is more complicated and requires the assumption that each cost driver linked to every product, within a component, causes identical costs to be incurred by the component or activity which *perfectly allocates* joint and common component-level costs to products within each component.

PR Comments, pp. 25-6 (emphasis added). In no sense does the Postal Service's cost driver analysis rely on an *allocation* of joint and common costs.

The basic logic of the Postal Service method is quite simple, but bears repeating. The costs assigned to each cost component reflect the total costs of providing a particular postal function (*e.g.*, transportation or sortation) that is used by several Postal Service products. By definition, the total level of component costs is jointly determined by *all* of the product volumes that utilize the component in question. For a large share of these costs, however, the specific activities whose level individually determine, or *drive*, the amount of component costs can be identified. For example, transportation costs may be driven by the number of total cubic inches of the pieces transported, while sortation costs may be driven by the total number of pieces sorted. The key simplifying assumption, as expressed in the above quotation, is that the impact of, say, each cubic inch on total transportation costs is the same regardless of which Postal Service product contributed that cubic inch. The other simplifying assumption behind the Postal Service's distribution method is that of *linear homogeneity*: i.e., that a doubling of the volumes of all products utilizing a cost component doubles that

component's level of driver activity.[9]   Together, these assumptions make possible the

distribution to individual products of component costs that vary at the margin with changes in

the output of those products. However, contrary to the claims of the Public Representative,

these assumptions do not directly establish a *causal relationship* between product volumes and

component variable costs that do *not* vary with marginal changes in the output of any

individual product.

The Public Representative repeatedly attempts to justify the causal relationship

between individual products and component inframarginal costs by analogy to volume

variable costs. The thrust of the argument is that, because marginal and attributable costs of

components can be "allocated to products using a distribution key," so can the inframarginal

costs that are caused jointly or in common by multiple products:

> At the component-level of analysis, variable costs are jointly caused by all the
> volumes of all the products that utilize that component. With the Commission's
> decision to accept the notion that these component level costs can be allocated
> to products using a distribution key, the Commission implicitly accepted that
> there is a causal link between a component's volume variable cost that is jointly
> caused by products and the products that utilize that component which can be
> perfectly attributed to each product according to the extent to which it
> contributes to component-level common costs.

PR Comments, p. 26. On the basis of this interpretation of the Commission's use of

component cost distributions to individual products, the Public Representative reaches the

further conclusion that:

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[9] In practice, a linear relationship is assumed between the level of component driver activity
and product volumes. That is, the total level of component driver activity is a weighted sum
of the volumes of the products that utilize that component. The weights may differ across
products because, for example, a flat may contain more cubic inches than a letter.

The evidence for causality of inframarginal costs is identical to the currently accepted evidence that volume variable costs are causally related to products.

PR Comments, p. 26.

The basic flaw in this reasoning is its disregard for the distinction between individual and joint causation. Component variable costs are jointly caused by all products. The fact that a distribution key can be used to *allocate* some of them (e.g., volume variable costs) or all of them (as under Proposal One) to individual products does not mean that the resulting costs were *caused* by those products. When component marginal costs are constant, the causality of the marginal unit through the distribution key can be multiplied by the number of units. However, this identity does not hold if the component marginal cost curve is declining because some variable costs are inframarginal. They are caused jointly by two or more products, and therefore are not caused by any individual product.

The failure of the Public Representative to recognize this distinction is particularly remarkable because the Public Representative actually cites the portion of my 2014 report to the Commission that emphasizes the distinction:

> However, it is important to avoid the temptation to view the volume variable costs distributed to a particular product as being caused by that product. The *variable* costs of a component are jointly caused by all the volumes of all the products that utilize that component. These costs may be distributed to individual products based on that product's share of driver activity. Panzar at 13.

PR Comments, p. 29 (emphasis in original). He omits, however, the remainder of the same paragraph:

However, unless component marginal cost is constant, the resulting cost distribution to product i is *not* the amount of cost that would be *avoided* if product i were to be discontinued: i.e., it is not the incremental cost of product i.

Panzar (2014), p. 13 (Emphasis in original). Thus, far from supporting the Public Representative's claim, my earlier analysis clearly makes the point that the distribution of component variable costs to individual products does not establish that the costs so distributed are *caused* by that product.

4. Conclusion

Nothing in the initial comments of NPPC, Valpak or the Public Representative provides a valid basis for adopting Proposal One. Proposal One advocates an attribution methodology that is not based on cost causality and should therefore be rejected by the Commission.

VERIFICATION

I, John C. Panzar, declare under penalty of perjury that the foregoing is true and correct. Executed on March 25, 2016.